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I, LEANNE MYNOTT, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PQ 3077 for a patent by RITEMP PTY LTD filed on 24 September 1999.

WITNESS my hand this
Twenty-third day of October 2000

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ORIGINAL

PROVISIONAL SPECIFICATION FOR AN INVENTION ENTITLED

Invention Title: IMPROVEMENTS RELATING TO COOLING OF DIES

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The invention is described in the following statement :

This invention relates to cooling of machines.

Such machines can include dies of a type useful for molding of materials of a type including but not limited to plastics materials.

I have previously described in a co-pending Patent Application which is not yet public or published, an arrangement in which there is a chamber within a die which is partially filled with a liquid and a remainder of the chamber is filled substantially only with the vapour of the liquid.

There is arranged a condensing arrangement positioned in relation to a source of heat within the chamber so as to cool and condense thereby vapour formed as a result of conversion from the liquid from the source of heat.

This arrangement has been found to have significant advantages in keeping temperatures of portions of the die at relatively similar temperatures and therefore those parts of the die that are used for defining the shape of a molded article and are to be cooled from time to time to assist in the cyclic use of the die, can be kept at more uniform and even temperatures through their usage period.

One of the problems encountered has been that the head of any liquid within the chamber causes the liquid at a deepest point within a body of the liquid to be implicitly under a higher pressure and therefore the liquid at greater depth will "boil" at a higher temperature than the liquid at lesser depth. This then will result in temperature differences where it would be better if these differences were not so large.

Generally it is an object of this invention to provide a further arrangement to assist in keeping more uniform temperatures in a machine using this general concept.

In one form of this invention, although this need not necessarily be the only or indeed the broadest form of this, there is proposed a machine which includes an arrangement to assist in cooling of the machine including at least one closed chamber within the machine, the chamber being only partially filled with liquid and a remainder of the chamber being filled with substantially only vapour of the liquid within the chamber, at least a portion of the chamber being positioned to transmit heat from a targeted location of the machine into liquid within the chamber, and condensing means adapted by reason of heat

exchange to effect condensation of vapour within the chamber, the machine being characterized in that the liquid is arranged to be held in the chamber in such a way that the liquid will be distributed to reach or be held at different heights within the chamber.

In one form of this invention this is achieved by having the liquid including a foaming agent .

The surprising discovery is that by having the liquid arranged to foam as it is being caused to boil results in the liquid rising as foam containing vapour of the liquid to significantly extend the liquid as a film through the chamber. This then coats the walls of the chamber with liquid.

This has a result of wetting and keeping wetted the inner surfaces of the chamber without the height of the liquid reflecting in any substantially increased head.

In preference in this example the liquid is predominantly water and the foaming agent is a surfactant.

In trials conducted so far, the results have indicated a significant improvement in the use of water to maintain uniformity of temperature especially when the temperature is relatively low such as temperatures in the vicinity of 25 degrees Centigrade. If there were to be a significant head of water then the water at a bottom of this head is under the additional pressure of the head of water and will "boil" at a higher temperature which can be higher than that which is ideal in some cases or acceptable in other cases.

This then also allows for the quantity of water needed in the chamber to be reduced from what had previously considered to be necessary. This then allows for the chamber to be of substantial depth without there inevitably being a head of liquid such height that there will be caused an unacceptable boiling temperature difference of water at a top of a body of water as compared to water at a bottom of the body of water.

In a further form the invention can be said to reside in an arrangement to effect control of temperature of a die including at least one enclosed chamber within the die for water with a foaming agent together within the chamber substantially only the vapour of the liquid within a space above the liquid within the chamber, at least a wall of the chamber below heat exchange

cooling within the chamber being adapted to transmit heat from a targeted location of the die into the liquid within the chamber to effect a transforming of this into the vapour of the water, and to effect condensation of vapour, further characterised in that there is in, at least one such chamber, means to effect passage of liquid into a passage forming a part of the chamber having dimensions where surface tension of the liquid would otherwise inhibit passage of liquid thereinto.

In a further form there is provided in preference an arrangement to effect control of temperature of a die including at least one enclosed chamber within the die for liquid together with substantially only the vapour of the liquid within a space above the liquid within the chamber, at least a wall of the chamber below an upper level of the liquid within the chamber being adapted to transmit heat from a targeted location of the die into the liquid within the chamber, and heat exchange means within the chamber positioned relative to a source of heat within the chamber and adapted by reason of heat exchange to effect condensation of such vapour further characterised in that there is in, at least one such chamber, means to effect passage of liquid into a passage forming a part of the chamber having dimensions where surface tension of the liquid would substantially inhibit passage of liquid thereinto.
Such an effect can be alternatively referred to as a situation where a vapour lock occurs.

In a further form in preference there are provided means to hold some of the liquid in a reservoir which is, therefore, in conjunction with the size and shape of the chamber and the quantity of liquid in the chamber, providing a head of liquid for use for directing a stream or other flow of the liquid through one or more conduits into places which would otherwise be inaccessible to liquid by reason of vapour lock occurring.

In a further arrangement there is provided a substantially vertical conduit with a lower inlet and an upper outlet and a heat source adjacent a part of such conduit, and a means to hold any liquid lifted through the conduit by boiling of liquid effecting a percolator type effect, at a height above a normally existing upper level of liquid in the chamber.

The addition of a foaming agent has the advantage that once boiling occurs anywhere within the liquid, this foam and the water as a film implicit in the foam will readily extend in the manner of foam through the chamber and

thereby carry the small amount of water that forms the film forming the foam bubbles with it.

The physical quantity of water that is carried on the foam can be small. Even smaller quantities of liquid however, in the chamber (which will usually be water), will be sufficient because of the technique being used.

What we can have then is a relatively small amount of water with a relatively small amount of foaming agent such as a surfactant appropriate to create foam.

With water being the liquid, if air is then substantially removed from the closed chamber, then boiling will only occur when the temperature of the water is raised above that which will cause a boiling of the water within the defined vapour pressure then existing within the chamber.

If the quantity of water is very small so that it might amount only to perhaps a small percentage of the total volume of the chamber, then with appropriate design of the chamber, the maximum height of water within the chamber can be kept very small indeed.

It has been found in practice therefore that using the feature of a foaming agent, allows for a significant reduction in the quantity of water necessary for the purpose of holding a more uniform temperature within the die or other machine. On the other hand, it allows for large and complex dies to be designed with shapes including a cooling chamber or chambers that would normally not provide ready access for such cooling liquid.

Recalling that a significant advantage of the arrangement described is that it is now easier to maintain a working temperature of all parts of the die within a selected variation over a working cycle of operation and over different parts of the die, it becomes possible now to design dies where cooling techniques which were previously available would not have kept the temperatures within an acceptable or at least a preferred range of temperatures This can assist with reduced cycle times for a molding process. Furthermore, this effectively eliminates corrosion from any oxidation in the cooling chamber.

The reason corrosion will be eliminated is that a closed chamber will enable the liquid to be used only where this has had oxygen removed, at least to a substantial extent and furthermore, will not have oxygen available by reason

of substantial removal of air from the space within the chamber and above the liquid level.

Some features of some dies may need some additional assistance in maintaining continuing liquid access for cooling purposes.

This situation is the case where the chamber has a relatively long and narrow conduit shape noting that the word "conduit" means entry into but does not necessarily mean passage to anywhere else.

In such a case, the surface tension of the liquid such as water in relation to the surface of the chamber may impede continuing access of liquid into the conduit shape or in other words a situation where a vapour lock effect may otherwise result.

Accordingly, there is proposed that there be means to gather liquid within the chamber but at a height higher than an entry position into the conduit shape and means to effect through an injector conduit, a supply of such liquid through the injector conduit into the conduit shape.

One form of obtaining liquid at a head above the entrance to the conduit is to have a reservoir beneath an area providing for condensing of any vapour within the chamber and then a conduit extending from such a reservoir down into the injector conduit which has an aperture through which the liquid then will flow at a rate depending upon the head of liquid and the size of the conduit.

With such a reservoir created, which can have then any number of conduits feeding from this into injector conduits as required, such a reservoir is arranged so as to be a relatively shallow reservoir which will quickly overflow in normal operations so as to return most of the liquid to a lower reservoir.

In an alternative arrangement, in preference there is provided a conduit which nonetheless forms a part of the closed chamber which has an inlet at a lower position within the chamber such that this inlet will be below a normal liquid level within the chamber, and an upper outlet which will direct liquid into a holding reservoir of the type previously described for feeding conduits to eventually feed injector conduits.

Further then, there is provided in an adjacent vicinity to this vertical conduit, a member to provide a source of heat targeted to any material within the vertical conduit.

The way in which the heat can be provided can vary significantly from an electrical resistance coil to a conduit connected to a hot water supply.

However, with such an additional heat source, the effect within the conduit therefore is to effect a boiling of the liquid within the conduit and the result that liquid in the manner of a percolator is then lifted by the rising vapour from the inlet through to the outlet.

In a further preferred arrangement, the result is achieved by having one or more dams or reservoirs which hold a limited amount of the liquid and which are arranged to collect the liquid from time to time during the "boiling" of the liquid in the chamber either by reason of rapid transition to vapour effects causing substantial ebullition and therefore implicit lifting of the liquid to appropriate heights, or by reason of condensate being directed to one or more of the dams or reservoirs.

There can be also in preference be a combination of foaming agent and distributed reservoirs or dams

Further. the reservoir or dam or dams can be arranged to overflow as they are filled with the liquid and this cascading effect can ensure that each of the reservoir and dams are kept to only a selected level and therefore head and therefore maintain a reasonably small range of temperatures at which the liquid will boil within that selected reservoir or dam.

For a better understanding of this invention it will now be described reference to preferred embodiments which shall now be described some with the assistance of drawings wherein:

FIG. 1 is a perspective view of one side portion of a die including a cooling chamber as in one form of the embodiment,

FIG 2 is a cross sectional view of a part used in a further form of the invention,

FIG 3 is a cross sectional view along the lines 4-4 in Fig 4 of a second embodiment, and

.FIG 4 is a cross sectional view of a second embodiment.

The drawing in Figure 1 shows one part or half of a plastics material injection die 1 where one half of the die has a quite arbitrarily chosen shape with a pin 2 extending from a middle of the molding shape 3. A die to be fully operational will have a further part (which is not shown) forming in this case a female receiving shape which further part can be cooled with an arrangement and method substantially the same as this first part.

In this first part, then, there is a chamber 4, which is arranged to be closed and to have water inserted therein and air removed.

The extent of removal of air is such that substantially all of the air is removed so that only the vapour of the liquid in the chamber substantially fills any remaining chamber area. The liquid which is water in this embodiment is first treated so that substantially all dissolved gases have been removed by, for instance, vigorously boiling the water at standard atmospheric pressure prior to insertion into the chamber 1.

This has the added advantage that the water will be generally without oxygen when in the closed area of the chamber and therefore cause negligible or no subsequent deterioration of any metal surface by reason of oxidation(e.g. rust) which generally cannot occur without a source of oxygen.

In this embodiment, a small quantity of household detergent has then been added to the water, the quantity being dependent on the actual detergent being used but generally is a quantity that will result in adequate foaming is all that is required and in the case of experiments so far, 1% by volume of household detergent has been added to the water. Alternative foaming agents can be used.

In order to reduce temperature differentials it has been found that if a quantity of water is held with the same head height, then the temperature, in these reduced pressure circumstances, at which the water will boil will depend on the level within the water at which boiling of that particular portion of water will take place. If this head is somewhat above 200 mm (e.g. 300 mm) then the temperature difference will start to be of significance. According if the quantity of water is chosen to not then fill the chamber to a height greater than approximately 200 mm then this is found to provide reasonable temperature uniformity. A temperature range between 20 degrees Centigrade and thirty

degrees Centigrade may in some cases be considered sufficiently uniform although in other cases a smaller range can be required and can be met by this invention and the principles espoused. The actual temperature difference required can be established and designed for.

Continuing with the description of the embodiment in Figure 1 this has a shallow trough 5 which is positioned immediately below heat exchanger 6 which is arranged to be kept cool by cooling water passing through the heat exchanger 6 and therefore effecting condensation of vapour rising in the chamber 4. The condensate is directed into the trough 5 and as it overflows the water will run down the side of the die part 1 into a main body of liquid (water with detergent).

However, a further percolator arrangement 7 is also in place to feed water into the trough 5. This has a vertical tube 8 with an inlet 8a at a bottom of the chamber in order to draw liquid into the tube 8 and an outlet 9 by which to direct lifted water into the shallow trough 5. A source of heat 10 is arranged alongside the tube 8 and this is provided with an electric resistance element so the quantity of heat can be easily controlled and therefore the quantity of liquid that will be lifted with this arrangement.

The value of having a higher level of liquid is that the height can be used to push liquid into places it otherwise might be reluctant to go. In this case we have a narrow passage 11 which has a needle injector 12 inserting liquid which is running down through tube 14 into the passage 11 where small quantities of liquid are found sufficient to keep the temperatures within an acceptable degree of uniformity.

Details of the needle injector are shown in Figure 2.

Clearly, the number of tubes and the number of needle injectors can be substantial where however 'the example is showing just one.

In Figures 3 and 4 the part shown is only one part of a plastics injection die and the matching other part or parts will have their own cooling arrangement.

Here we have then a chamber 15 which has a plurality of cascading reservoirs 16 and 17 which are fed by condensate from the condenser 19. Each reservoir 16 and 17 is shaped so that only a selected depth of water will stay in a respective reservoir and hence keep a temperature uniformity. The reservoir in

each case is defined by walls 20 which are arranged to allow for overflow of the liquid when filled and such that the overflowing liquid will flow into the next reservoir underneath the first reservoir. The drawing shows the arrangement where however the water will follow the inward inclination of the wall by reason of surface tension and therefore will cascade into the next reservoir.

In the cases of the two specific embodiments these can be used with the liquid having foaming agent so that some of the advantages of both answers can be achieved in a single die.

What has now been described will allow the design of dies (or molds or other machines) with the ability easily to keep temperatures within a more uniform range than hitherto and the invention described is considered to be of groundbreaking importance in the art.

Throughout this specification the purpose of the description has been to illustrate the invention and not to limit this.

Dated this 24th day of September 1999

RITEMP PTY LTD
By their Patent Attorneys,
COLLISON & CO.

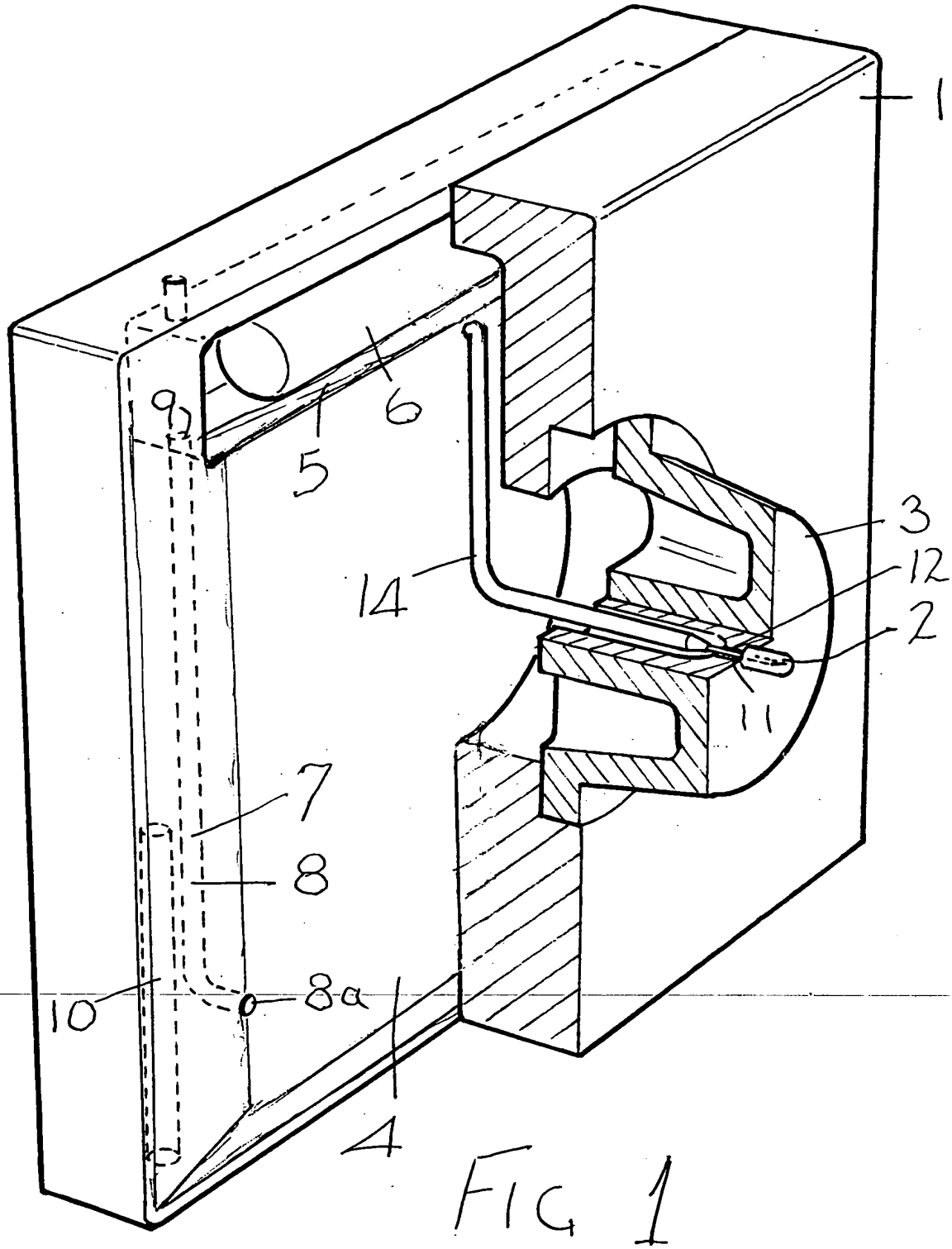

FIG 1

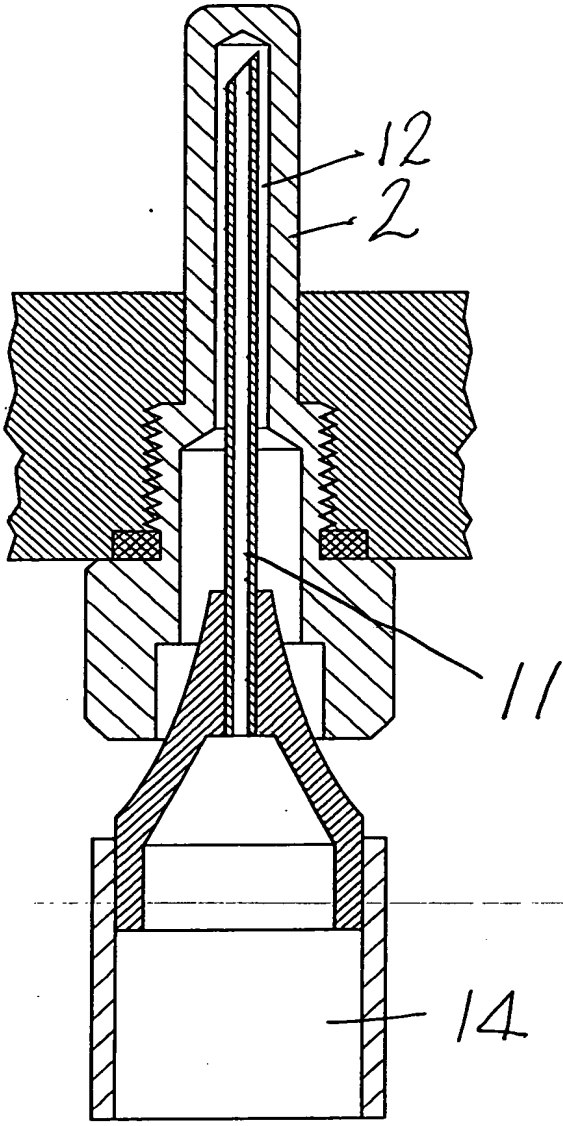

FIG 2

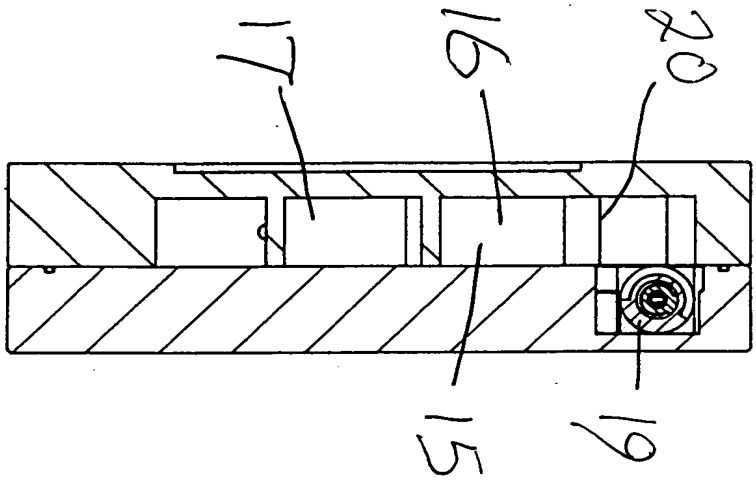

FIG 3

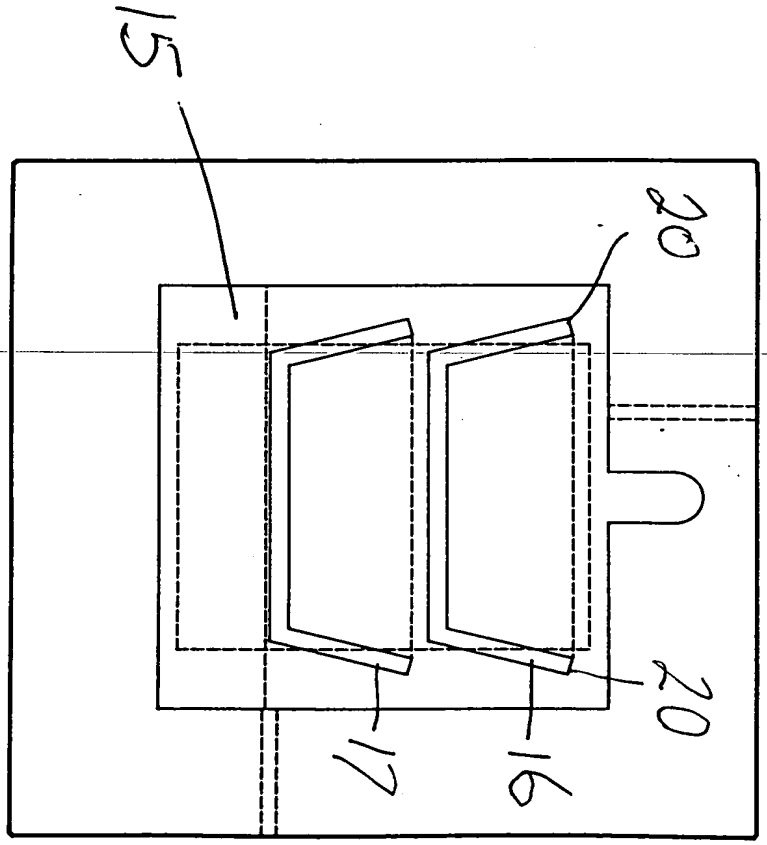

FIG 4